DOCUMENT RESUME

ED 196 702 SE 033 646

AUTHOR Flowers, John D.
TITLE Making Water Pollution a Problem in the Classroom Through Computer Assisted Instruction.
PUB DATE Oct 80
NOTE 20p.: Paper presented at the Annual Convention of the National Association of Biology Teachers (Boston, MA, October 23-26, 1980).

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Computer Assisted Instruction; Computer Programs; Educational Methods; *Instructional Materials; *Problem Solving; *Programed Instruction; Science Activities; Science Education; *Secondary Education; Secondary School Science; *Water Pollution

ABSTRACT

Alternative means for dealing with water pollution control are presented for students and teachers. One computer oriented program is described in terms of teaching wastewater treatment and pollution concepts to middle and secondary school students. Suggestions are given to help teachers use a computer simulation program in their classrooms. Formulating hypotheses, identifying and manipulating variables, analyzing computer generated data tables, and graphic displays are described with regard to problem solving. (Author/CO)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED196702

U S DEPARTMENT OF HEALTH
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

John D. Flowers, Jr.

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

SCOPE OF INTEREST NOTICE

The ERIC Facility has assigned this document for processing to: SE IR

In our judgement, this document is also of interest to the clearinghouses noted to the right. Indexing should reflect their special points of view.

MAKING WATER POLLUTION A PROBLEM IN THE CLASSROOM

THROUGH

COMPUTER ASSISTED INSTRUCTION

John D. Flowers
School of Education
Augusta College
Augusta, Georgia

Paper Presented At

The Annual Convention of the

National Association of Biology Teachers

Boston

October 23-26

1980

SE 033 646

MAKING WATER POLLUTION A PROBLEM IN THE CLASSROOM

THROUGH

COMPUTER ASSISTED INSTRUCTION

John D. Flowers

Water pollution is not a problem. A problem is any question proposed for solutions. Granted, water pollution may initiate many questions proposed for solutions; however, in and of itself water pollution is neither a question nor is it a well formulated statement of a problem.

Water pollution, in point of fact, is a phenomenon. It belongs in the same category as any fact or event of scientific interest susceptible of scientific description and explanation. It is a phenomenon in the sense that it is a scientifically describable event or process. For example, water from a polluted river can be touched, sampled, measured, and sometimes smelled. It can be analyzed and described in terms of chemical composition and effects on living organisms.

The phenomenon of water pollution becomes a problem when students and teachers begin raising questions and addressing situations concerning its impact on living organisms. Herein lies one of our greatest challenges as teachers of life sciences; namely, to implant within our students the skills of asking questions amenable to the problem solving approach common to all scientific research. Implicit in this challenge is the assumption that students should not only be

DEC 3 0 1980

able to react to questions asked by their teachers, but they should be able to proact or initiate the kinds of questions that lead to meaningful problem solving tasks.

Middle school and high school students are able and eager to ask questions concerning water pollution. However, the kinds of questions they usually ask require knowledge-type answers consisting of a name, or place, or date. Middle school students have great difficulty asking questions and analyzing situations which relate two or more abstract concepts or variables. For example, a sixth grade student could ask, "Does our town have a plant for waste water treatment?" This question requires a simple knowledge-type answer devoid of true problem solving and abstract reasoning. That is to say, the question does not lend itself well to the formulation of hypotheses, collection of data, and testing hypotheses. Although questions requiring recall of specific facts are important, good middle school teachers want their students to be able to use knowledge to solve problems; not to simply parrot back previously learned scientific facts. Middle school students should be given many opportunities to develop their newly emerging ability to solve problems by using abstract rather than concrete referents.

High school biology students should be given opportunities to further develop and refine higher order thinking. It is necessary that both middle and high school students acquire a large quantity of factual information regarding ecology related problems including water pollution; however, acquisition of a body of factual information should not be a goal in and of itself.

Developing Problem Solving Skills Via POLUT

One generally recognized way to insure that students acquire and use newly acquired knowledge about water pollution and other ecology related subjects is to present them with situations that require solutions. One generally unrecognized means to this end is the use of computer simulation programs available through most universities and large colleges.

A particularly appropriate computer simulation program focusing on water pollution is produced by Digital Equipment Corporation. Program POLUT provides repeated opportunities for students to proact with their environment through simulation. For example, students can investigate the effects of a number of variables on dissolved oxygen in water. They can state problems and test hypotheses within a fraction of the time normally required. The likelihood of asking problem solving type questions is thereby greatly enhanced by providing students with the means to test their hypotheses at a computer terminal in a relatively short period of time.

Many problem solving activities in the classroom often take days or weeks before results can be recorded and hypotheses tested. POLUT, on the other hand, provides students with immediate feedback on many possible hypotheses which are quickly tested by the computer. Immediate feedback appears to stimulate students to ask additional thoughtful questions and state alternative hypotheses.

Using POLUT in the Classroom

POLUT allows students to "see" consequences of certain actions

taken to control water pollution. Both graphic and tabular results of manipulated variables are printed on paper or a television moniter in a matter of a few seconds. The display of data and its comparison can be used to formulate additional hypotheses or predictions. Figure 1 outlines the variables and simple instructions for using POLUT.

Given the simplicity of working with the POLUT program, one can easily imagine the nature of questions students are motivated to ask. An example of a question students are likely to ask when allowed to manipulate program variables is, "When will water pollution kill fish?" The simple answer is that game fish begin to die when dissolved oxygen goes below 5 ppm. However, when working with POLUT, the student must initiate the selection of variable values which contribute to the diminution of dissolved oxygen. Thus, the student becomes aware of the interaction among two or more variables that directly affects pollution of a given body of water.

When using POLUT the student will learn that it is necessary to hold all but one variable constant in order to make valid judgments. Figures 2 and 3 illustrate these points by comparing graphs which reflect manipulation of a single variable. In Figures 2 and 3 the following variables and values are selected to remain constant:

Variable		Value
Body of water	=	Slow-moving river
Water temperature	=	65 degrees F.
Kind of waste	=	Industrial
Type of treatment	=	Primary

Figure 1

Interaction with POLUT

Computer: Do you need instructions (YES = 1, NO = 0)?

Student: (Type "1" to receive instructions.)

Computer: In this study you can specify the following:

A. Body of water
   1. Large pond
   2. Large lake
   3. Slow-moving river
   4. Fast-moving river

B. Water temperature (Fahrenheit)

C. Kind of waste dumped into body of water
   1. Industrial
   2. Sewage

D. Rate of dumping (ppm/day)

E. Type of waste water treatment
   0. None
   1. Primary (sedimentation or screen filtered)
   2. Secondary (sand filter or activated sludge method)

Computer: Body of water?

Student: (Type any number given by the computer.)

Computer: Kind of waste?

Student: (Type either "1" for industrial or "2" for sewage waste.)

Computer: Dumping rate?

Student: (Type a number between "0" and "14" ppm/day.)

Computer: Type of treatment

Student: (Type either "0" for NO TREATMENT, "1" for PRIMARY TREATMENT, or "2" for SECONDARY TREATMENT.)

Computer: Do you want: a graph (1), a table (2), or both (3) ?

Student: (Type "3" to get printout of both graph and table.)

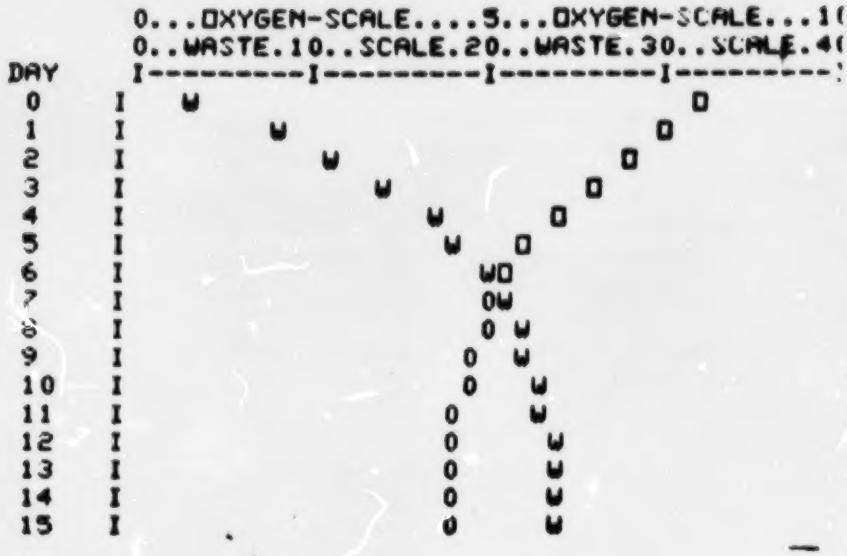
Computer: (At this point, the computer prints a table and graph.)

Computer: Another run (1 = YES, 0 = NO)?

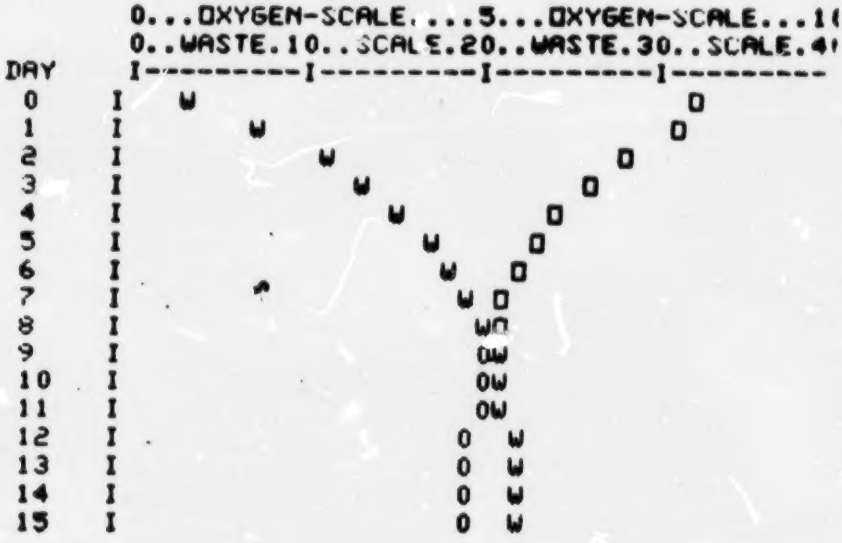
Student: (Student may begin another run of POLUT by typing "1" for YES. The computer then asks for the same information as before.)

Figure 2

Dissolved Oxygen In Water



A - Dumping Rate = 11 ppm



B - Dumping Rate = 10 ppm

TABLE 1

Data Corresponding to Figure 2-A

TIME DAYS	OXY. CONTENT PPM	WASTE CONTENT PPM
0	8	2.67
1	7.6	7.59
2	6.96	11.41
3	6.39	14.37
4	5.93	16.68
5	5.57	18.46
6	5.3	19.85
7	5.08	20.93
8	4.91	21.76
9	4.78	22.41
10	4.68	22.92
11	4.6	23.31
12	4.54	23.61
13	4.5	23.85
14	4.46	24.03
15	4.43	24.17

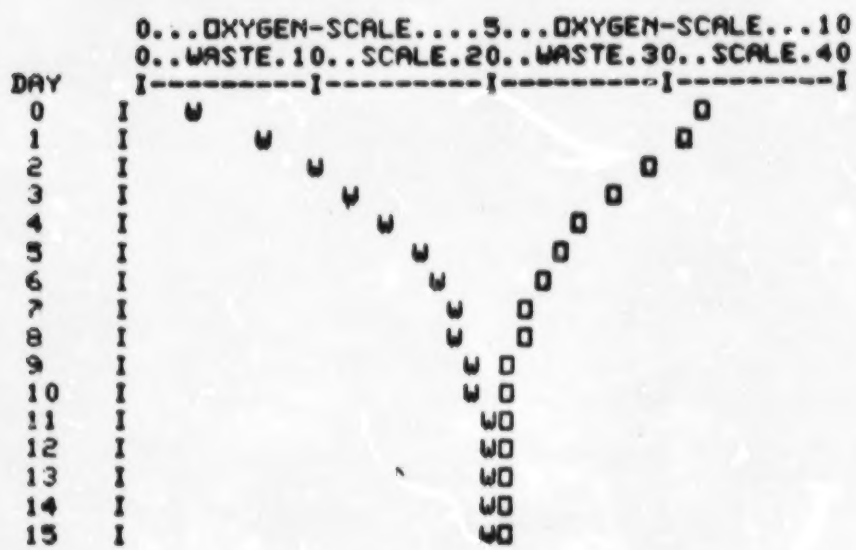
TABLE 2

Data Corresponding to Figure 2-B

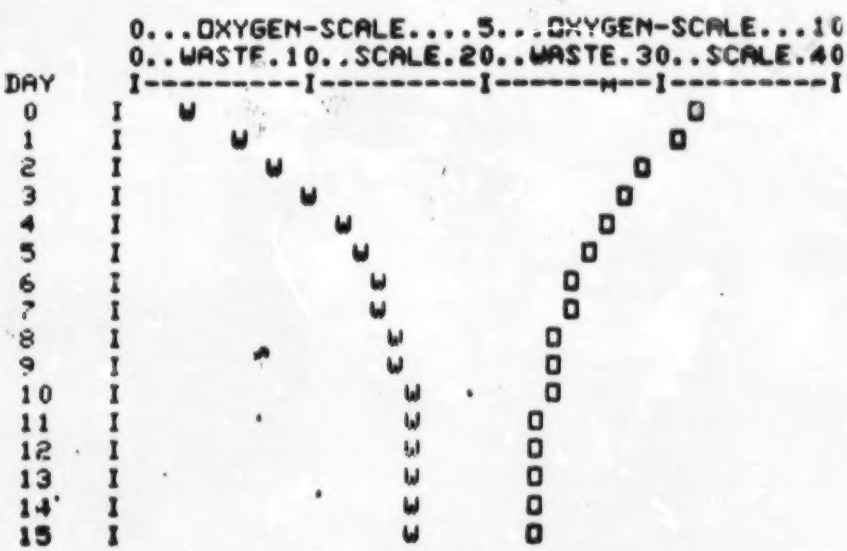
TIME DAYS	OXY. CONTENT PPM	WASTE CONTENT PPM
0	8	2.67
1	7.64	7.14
2	7.05	10.61
3	6.53	13.31
4	6.12	15.4
5	5.79	17.03
6	5.54	18.29
7	5.35	19.27
8	5.19	20.03
9	5.08	20.62
10	4.98	21.08
11	4.91	21.43
12	4.86	21.71
13	4.82	21.92
14	4.78	22.09
15	4.76	22.22

Figure 3

Dissolved Oxygen In Water



A - Dumping Rate = 9 ppm



B - Dumping Rate = 7 ppm

TABLE 3

Data Corresponding to Figure 3-A

TIME DAYS	OXY. CONTENT PPM	WASTE CONTENT PPM
0	8	2.67
1	7.68	6.69
2	7.15	9.82
3	6.68	12.24
4	6.31	14.13
5	6.01	15.59
6	5.79	16.73
7	5.61	17.61
8	5.47	18.29
9	5.37	18.82
10	5.29	19.24
11	5.22	19.56
12	5.17	19.8
13	5.13	20
14	5.1	20.15
15	5.08	20.26

TABLE 4

Data Corresponding to Figure 3-B

TIME DAYS	OXY. CONTENT PPM	WASTE CONTENT PPM
0	8	2.67
1	7.75	5.8
2	7.34	8.23
3	6.97	10.12
4	6.68	11.58
5	6.46	12.72
6	6.28	13.6
7	6.14	14.29
8	6.04	14.82
9	5.95	15.23
10	5.89	15.55
11	5.84	15.8
12	5.8	16
13	5.77	16.15
14	5.75	16.26
15	5.73	16.35

The manipulated variable is DUMPING RATE. Figure 2-A indicates a DUMPING RATE of 11 ppm. It can also be noted that game fish begin to die after day 7 because the oxygen content of the water dropped below 5 ppm. Students can see that Figure 2-B represents a small improvement in that the fish begin dying after day 9 when the DUMPING RATE is reduced by 1 ppm. Although oxygen content is dangerously close to the 5 ppm level as indicated in Figure 3-A, students can see that a reduction of the DUMPING RATE from 10 to 9 ppm results in conditions satisfactory to support game fish. A further reduction of the DUMPING RATE from 9 to 7 ppm results in a significant reduction of waste as well as a significant increase in dissolved oxygen. A student could thus predict the point at which the DUMPING RATE for a slow-moving river would result in dangerous pollution; other variables held constant.

Another question students are likely to ask when using POLUT is, "How does the type of waste water treatment affect fish life?" At this point the teacher can ask each student or team of students to write one or more hypotheses they would like to test. If students have already studied the operation of primary and secondary treatment plants they may offer an hypothesis similar to the following: "Dissolved oxygen in water is greater when secondary treatment is used." In order to test this hypothesis, students would simply hold all variable values constant except for TYPE OF TREATMENT.

Assume that a student refers to data previously generated such as that in Table 1 or Figure 2-A. Further assume that the student enters the same variable values except for TYPE OF TREATMENT. For the

manipulated variable, the student types a "2" which tells the computer that the type of treatment will be secondary instead of primary. The student receives data from the computer and compares them to previously collected data. Table 5 indicates the contrast between oxygen content as a function of the type of treatment used. Thus, the hypothesis stating that dissolved oxygen is greater when secondary treatment is used cannot be rejected. The graphs in Figure 4 emphasize the stark difference between type of treatment variables and help the student to "see" the advantage of using secondary treatment of waste water.

Getting POLUT in the Classroom

There are at least three options open to teachers who would like to make POLUT available to their students:

1. Allow students to use in-house terminal(s) if POLUT can be handled by existing hardware.

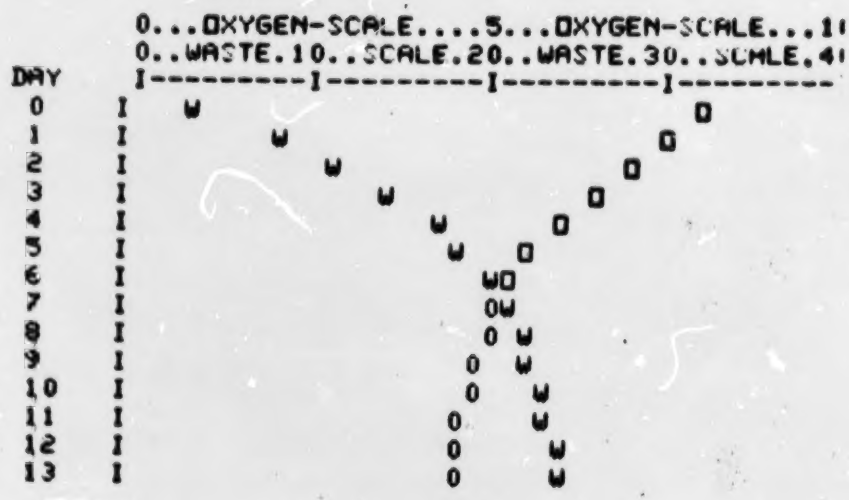
For those teachers who are in a school that has micro-computers or larger computers with paper tape read-in capabilities, it is possible to program the computer. When the paper tape is read by the computer it is automatically stored in the computer's memory and is available for use.

2. Take students on a campus where POLUT and computer terminals can be found.

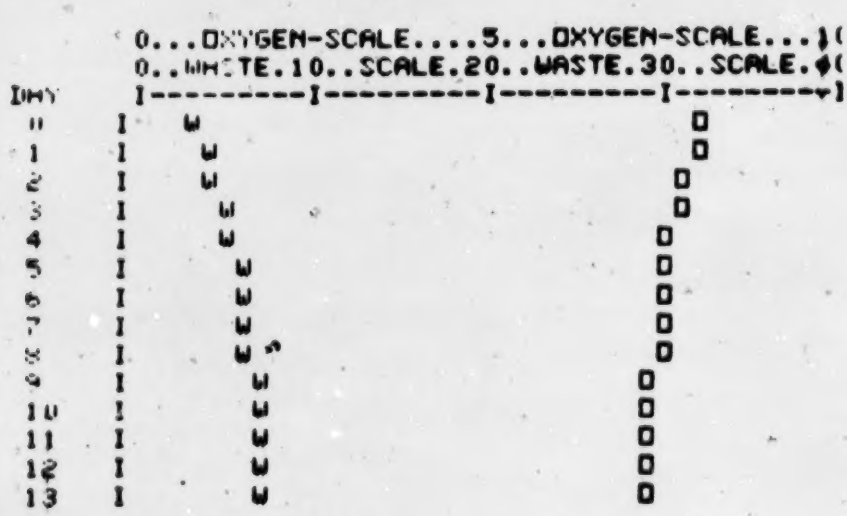
Teachers who are near a university should contact the university's division of computer services. Permission may be given to take a small group of students on campus where they can gain access to computer terminals for a limited period of time. Given sufficient instructions regarding the nature of POLUT, and given opportunity to write two or three hypotheses to be tested before the visit, students would need

Figure 4

Types Of Treatments



A - Primary Treatment



B - Secondary Treatment

TABLE 5

Data Corresponding to Figure 4-B

TIME DAYS	OXY. CONTENT PPM	WASTE CONTENT PPM
0	8	2.67
1	7.92	3.65
2	7.79	4.41
3	7.68	5.01
4	7.59	5.47
5	7.51	5.83
6	7.46	6.1
7	7.42	6.32
8	7.38	6.49
9	7.36	6.62
10	7.34	6.72
11	7.32	6.8
12	7.31	6.86
13	7.3	6.9

no more than 15 to 20 minutes of computer terminal time.

3. Teacher collects data which are returned to students for purposes of testing hypotheses.

It may be most feasible for teachers to access POLUT on a university or in-house computer and enter variable values previously suggested by students. For example, a class of thirty students could be divided into 5 teams of 6 students each. Each team would discuss the variables in context of their knowledge of water pollution. One way to get realistic variable values would be to arrange for students to visit a waste water treatment plant. After ascertaining the values for POLUT variables one group of students may decide to test the hypothesis that the present values result in a level of pollution that endangers fish life in a nearby river. Another group may wish to change the type of treatment to test the hypothesis that a different type of treatment will be more effective in keeping the river clean. After each group of students states its own hypothesis and provides the teacher with values for specific variables in the POLUT program, the teacher enters the data into the computer. Results are collected by the teacher and returned to students who then decide whether their hypotheses are to be rejected or accepted. This process could be repeated as practicable.

It may appear that a lot of additional teacher time is being invested; however, the actual time needed to put values of variables into the computer and receive print-out of both graphs and data tables for five hypothetical groups of students is approximately 10 minutes. The outcomes are well worth the investment.

POLUT for Middle and High School Students

POLUT is designed for students in grades 10 through 12; however, middle grade teachers find that the program is applicable to students and content in grades 6 through 8. The major cognitive factors limiting use of the program are ability of student to interpret graphs, and ability to acquire basic knowledge of some terms related to water pollution and waste water treatment. Prerequisite knowledge is described in the Teacher's Guide which is available from Digital Equipment Corporation. A Resource Handbook and a Student Workbook are also available and most helpful in planning classroom activities. All documents are reasonably priced, but they are not absolutely essential components.

Summary

A. Water pollution becomes a problem when questions are raised concerning its impact on living organisms.

B. Not all questions lend themselves to the problem solving process.

C. Middle and high school teachers should give students increasing opportunities to ask questions, state and test their hypotheses within a reasonable amount of time.

D. Computer programs such as POLUT allow students to formulate problem-type questions, state hypotheses, test hypotheses by manipulating one or more variables, and "see" the consequences of their actions.

E. There are at least three options available to teachers who wish to use POLUT and other computer simulation programs:

   1. Arrange for students to interact with POLUT on in-house computer facilities.
   2. Arrange for students to interact with POLUT on computer terminals on a university or college campus.
   3. Teacher interacts with POLUT and provides students with results.

F. Teachers do not have to be computer experts or know how to program computers in order to take advantage of Computer Assisted Instruction programs such as POLUT.

NOTE: POLUT is one of many computer simulation programs developed by the Huntington II Computer Project, State University of New York, Stonybrook, New York.

Exclusive publishing rights are granted to Digital Equipment Corporation with corporate headquarters in Maynard, Massachusetts 01754. Write to this address for further information about available programs and costs.